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come out from their concealment and meet the underside of the insect where pollen may be left or received. Why the style should be so uniformly curved upward, and all should be brought against the abdomen of insects, I cannot well conceive, unless it be of some use to the plant.

Lupine, another species in this family, has a remarkably long keel which makes a close sheath for the inside parts. On the style, just below the extremity, is a circle of long stiff bristles. As the keel is pushed down, only the stigma, with the bristles below, appears outside, and this pushes out a mass of pollen which generally hits some part of the insect. When left, the flower resumes its former position again.

For about six times pollen can be pushed out in this way, when the supply becomes exhausted. Insects begin on the lowest flowers, and so go up the spike to others which are higher and younger. No experiments have been made on Lupine to show whether it will produce more seeds when visited by insects than when protected.

# ICE-MARKS AND ANCIENT GLACIERS IN THE WHITE MOUNTAINS.

BY A. S. PACKARD, JR., M.D.

DURING a visit last autumn to the White Mountains, we found ice-marks in the valleys of the Saco, Ellis, and Androscoggin Rivers. These grooves, and other signs of ice action, give the clearest evidence, that, during the Glacial Period, the White Mountains were covered by a central *mer-de-glace*, which discharged local glaciers into the principal valleys radiating from the central peaks.

Like the glaciers of the Alps, of the mountains of

Norway, of the Himalaya Mountains, and the mountains of New Zealand, the Andes, and the polar regions at the present day, these rivers of ice flowed down the valleys, like a plastic mass of frozen and refrozen snow and ice. We learn from the writings of geologists that in former times the Alpine glaciers, which now cling to the mountain peaks far up the valleys, descended during a period of great cold, when the Polar Bear, Reindeer, and other arctic animals were spread over Southern Europe, and extended far out upon the broad plains of Italy and Germany. Such must have been the scene in New England during the time of intense cold, known as the Glacial Period. But before theorizing, let us present the facts which seem to us new, and to confirm the opinions that have been before expressed by some of our geologists, that the principal valleys of the White Mountains have been filled with these rivers of ice. Our observations only relate to the eastern part of the mountains.

Let us first explain what is meant by ice-marks or glacial scratches, *striæ*, grooves, and moraines. The rocks and ledges in all the Alpine valleys are grooved and fluted by nearly parallel marks made by gravel and pebbles frozen into the bottom and sides of the slowly-moving mass of ice. The glacier thus grinds down, polishes, and scratches the rocks over which it moves. So steady and uniform is the motion of these immense bodies of ice, that the marks preserve a remarkably uniform course over the uneven surface of the valley. Sometimes a huge ledge projects into the valley. Around this the glacier sweeps, and the marks are curved at this point. Where the glacier debouches on to a broad plain, the ice-marks tend to radiate outwards, fan-like, from the mouth of the valley.

Moraines are formed of the debris or loose refuse matter accumulated either upon the surface, or crowded beneath the ice. The material derived from the latter source forms masses of clay, sand, and rounded stones, the latter of which are often found to be striated on one or more of the sides, like the surface of the solid rock beneath. On the top of the glacier rest long rows or trains of more angular blocks which have fallen from the cliffs above. These windrows of stones are called "lateral moraines," because they are found on each side of the glacier. When such a glacier melts away, a great semicircular heap or hillock of stones and dirt forms what is called a "terminal moraine." We would naturally expect to find the finer, clayey portions with rounded stones, grooved and scratched pebbles, and boulders at the bottom of the rude mass, while the more angular stones would remain upon the top. From the melting of the ice arise rivers whose turbid and swollen waters rush out from beneath the end of the glacier, and further aid in rounding the stones. Such torrential streams are the sources of the Aar, a branch of the Rhine, of the Rhone, and of other rivers which spring out from under the glaciers of the Alps and of Norway.

Our route to the mountains lay up the valley of the Ossipee River, in which Ossipee Lake, Six Mile Pond, and numerous other ponds lie. Looking from the village of Ossipee up the broad valley at the head of which rises the majestic Chicorua, and beholding on all sides lateral moraines thrown up in hillocks of partially stratified gravel and pebbles, and the beautiful glacial lakes embosomed in the gently swelling hills of this delightful valley, it was not difficult to imagine that old Chicorua, in former times, shook off from its icy dome streams of ice which crowded far up, and even overflowed the sides of this valley, and when all had melted away, left as witnesses of the floods these placid lakes. These sheets of water, however, are not scattered at random over the face of New England. In this valley and the neighboring parts of Maine, they are arranged in a general north-west and south-east course, following that of the rivers. This direction is probably due to the fact that the valleys cut across the general north-east and south-west course of our mountain ranges, which compose the Appalachian chain.

We had no time to search for glacial scratches in the Ossipee valley, but cannot doubt that on examination they will be found pointing towards Mount Chicorua, where, according to Dr. C. T. Jackson,* they follow the general north-west course of this valley.

Riding up the Conway valley, with Kearsarge on our right, and the Mote Mountains on our left, up through Bartlett to Jackson, we observe moraines innumerable rising high up the sides of the valley, and covered with boulders, revealed more distinctly in all the cleared lands. Above these moraines rise rounded and embossed rocks, while the evenly terraced valley, over which the road passes, shows that at a former period (though long after the close of the glacial epoch) the river, then a series of broad lakes, rearranged and resorted the confused materials composing the mounds left by the melting glacier, into finely, evenly stratified fresh-water deposits, which now form the arable land of the plains, over which are scattered the picturesque villages and hamlets so familiar to the White Mountain tourist.

Ice-marks were first noticed at Jackson, on Thorn

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* Report on the Geology of New Hampshire.

Mountain, a peak lying just south of Tin Mountain, and estimated by Prof. Guyot to be 2,500 feet high. Here the grooves are well marked, and point directly towards Mount Washington, their course being north 25° west. Even portions of a quartz vein which appears upon the surface is smoothly polished and finely striated. On removing the soil from the surface of the rock a part of the way up the mountain, and also directly upon the summit, these ice-marks could be easily discerned, all running in the same north-west and south-east direction. On Mount Kearsarge, three miles distant, which bears south 25° east from Thorn Mountain, Dr. Jackson states, in the Geology of New Hampshire, that part way up the mountain the drift-marks run north 35° west,—thus pursuing the general north-west and south-east course the valley here assumes. In hastily ascending this mountain on the north side from Jackson, we were not fortunate enough to discover any grooves in the rocks. Half way up the side, however, we found a boulder of a peculiar mica slate, containing large crystals of staurotide, or cross-stone, which must have been borne down on the back of the glacier from Mount Washington, as thick beds of this rock occur near the limit of trees, a little over four thousand feet up that mountain. Similar boulders occurred on some of the hills below.

On an adjoining hill near Goodrich's Falls, are very distinct ice-marks. Here we found a huge angular boulder of many tons weight, which had been apparently detached from the parent rock beneath, and moved a few rods to the south-east; for to the north-west are polished surfaces and grooves which had evidently been made by this large, slowly-moving mass of rock when frozen into the bottom of a glacier. The surface of the reddish sienite had here been polished smooth as porcelain, as seen in little patches which had survived the centuries of weathering by frosts and snows, which has effaced most of the slighter traces of glacial action in our mountain regions. Here the marks pointed north 30° east. There were also strange marks in the rocks, called *lunoid furrows*, which are crescent-shaped depressions in the rock, with the concavity looking towards the north. The origin of these lunoid furrows have been thus explained. It is known that the glacier is in constant motion, advancing a few inches in summer, and then contracting in winter. Now imagine a stone frozen into the ice, and thus acting as a gouge. Pushed onward and then withdrawn by the powerful hand of the ice-king, it soon wears this peculiar shaped hole, then turns over out of the rut, and catches again in some inequality of the rock, and makes another lunoid furrow, or perhaps a series of four or five, often very regular in form, though the distance between them may vary.

Crossing over the range of mountains north of Mount Kearsarge into Stowe, Maine, we descend into the charming valley of the Cold River. This is a branch of the Saco, and, though now comparatively unknown, it must in future attract many travellers. We pause at the entrance of Evans' Notch, a mountain pass of great interest, and far surpassing Pinkham Notch in grandeur, reminding us rather of the White Mountain Notch. The gate of the pass is guarded on the west by Mount Royce, on the east by Speckled Mountain, whose nine spurs radiate into the towns of Stowe, Albany, and Stoneham. On the broad, flattened, glaciated summit of Speckled Mountain ice-marks abound, pursuing a course north 15°

east, following the course of the valley at this point, and pointing towards a higher peak situated a little to the northward.

In one place a beautiful beryl, in fine crystals of which the coarse granite abounds, has been sliced off by the abrading agent, and polished even with the surface of the feldspar matrix. There are broad surfaces of rock planed down by ice, both on the north-western and north-eastern slopes, showing that the ice must have slid down in both directions from the reservoir of snow which rested on the water-shed between the two valleys. Here, also, occur numerous lunoid furrows, pointing in the same general direction as the straight fine grooves. In the fields, at the bottom of the mountain, are several parallel trains of boulders, formerly lateral moraines, which lie ten or fifteen rods apart. We were informed that these windrows of boulders stop the plough, and it is only possible to turn the sod in the intervals between them, which are entirely free from boulders.

On Mount Baldface, which lies about three miles west of Speckled Mountain, and is composed of a pale fine sienite, with an unusually perfect rift, enabling it to be split into long thin slabs for building purposes, the glacial marks assume quite a different direction, running north 10° to 15° west. On the north-east face, perhaps five hundred feet below the summit, may be seen striæ and lunoid furrows in abundance, running over a smoothly glaciated spur, on which the striæ run north 10° west. Here the lunoids were quite abundant. Some were very large, measuring from one to three feet in diameter.

On the summit of the mountain rest several angular boulders of a peculiar porphyritic sienite, containing curious oblong crystals of albitic feldspar. Our guide to their source—the trusty ice-grooves—point to Peaked Mountain, a peak lying perhaps half an hour's walk in a direction north 10° west. Under their guidance, and by occasionally following the paths made by bears through the stunted growth of spruce, we find the parent rock from which they had been torn, on the summit of Peaked Mountain, which is composed of this peculiar porphyry.

Passing through Evans' Notch into the valley of the Androscoggin, in the town of Gilead, we find marks on a ledge near the river, which follow a general north-west and south-east direction. This is the general course of the Androscoggin River at this place. Following this river to its mouth, where it empties near the sea-shore into the Kennebec River, the traces of glaciers observed at Bethel, Lewiston, and Brunswick show that a stream of ice once filled the valley throughout its whole length, from the mountains to the sea.

There was also a Peabody River glacier, which joined the Androscoggin glacier, as we may call it, at the junction of those two rivers near the Alpine House, at Gorham, N. H. A geological friend has detected on the north-east side of Mount Washington, on the carriage road, glacial grooves which point down the Peabody valley.

Thus we see the traces of five distinct ancient glaciers, filling as many river valleys, descending from the higher peaks of the White Mountains. In rounding off the tops of the mountains, scooping out the valleys, and levelling with their moraines the deep depressions in the surface of the earth, they were important agents in preparing the way for the advent of man, who should till the soil they have borne down from the mountains and spread out in fertile plains.

Such are the lessons to be learned of drifted boulders, ice-marks, and moraines. Now looking back through the past, perhaps even hundreds of thousands of years, when an ice-dome capped these mountains, then probably rising much higher above the sea, and sending a glacier down each broad valley into the ocean, where their huge icy cliffs were laved by the waters of a frozen sea, we have to imagine ourself as if on the present coast of Greenland or Spitzbergen, and, looking inland from some mountain peak upon the coast, behold a vast sea of ice with jagged peaks rising up through the broad expanse, cleaving and throwing aside the slowly, imperceptibly moving currents of this inland sea of ice. Near the sea, partly warmed perhaps by the remote influence of the Gulf Stream, whose powers upon the coast of New England were greatly lessened during this period of intense arctic cold, were sunny valleys, carpeted with moss and sprinkled sparingly with lovely arctic flowers,—whose descendants still linger upon the summit of Mount Washington,—half-hidden beneath the snows, or clinging to the cliffs as if shrinking from the icy embrace of the glacier. Here the Reindeer and the Bison* met in herds, the arctic Foxes barked, and the arctic Hare nibbled the short summer's growth; while upon the drifting ice-cakes the Polar Bear sat watching for some stray seal, and the Mammoth, found fossil over the northern part of both hemispheres, stalked over the plains. The Gare Fowl, or Penguin of the north (*Alca impennis*), probably reared its young, fattening them on the Caplin, which has been found fossil in our clay-beds; and the smaller Auks, the Gannet, the Puffin, and Eider Duck filled air and water with their hosts. Through the waves, schools of Narwhales may have disported and waged war with that Bull-dog of the northern seas, the Killer; while the Walrus and Greenland Seal thrust their half-dog, half-human face above the waves, and with angry bark, crowded and jostled each other off the smooth-backed skiers skirting the coast.

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*The teeth of the Walrus and the Bison were discovered by Sir Charles Lyell in the clay-beds at Gardiner, Maine. These are still preserved in a private collection. The association in the glacial clays of the remains of the Bison with those of the Walrus, and the mingling of other arctic animals and plants with those now confined to British North America and New England, show that the climate, during the glacial period, was a little warmer than that of Southern Greenland at present. Though New England was covered with land ice, the climate of the Middle and Southern States, so far as indicated by fossils, did not differ greatly from what it is at present. Even while the Walrus and other arctic animals inhabited New England, the coral reefs of Florida were forming.

Did man gaze upon this scene? Did the forefathers of the Mound Builders or of the ancient Copper Miners of the Great Lakes ply these waters in their kayaks, and build their winter huts of snow amid these arctic scenes?

## REVIEWS.

AN INQUIRY INTO THE ZOÖLOGICAL RELATIONS OF THE FIRST DISCOVERED TRACES OF FOSSIL NEUROPTEROUS INSECTS IN NORTH AMERICA; WITH REMARKS ON THE DIFFERENCE OF STRUCTURE IN THE WINGS OF LIVING NEUROPTERA. By *S. H. Scudder*. From the Memoirs of the Boston Society of Natural History. Vol. I. pp. 20, 4to. 1867. With a plate.

The study of the fossil remains of insects is attended with great difficulty. Indeed less is known, perhaps, of the Insect Fauna of former geological periods, than of most other classes of animals, with the exception of the worms and jelly-fishes (*acalephs*). From the fragments of wings, legs, and other hard parts of the insect crust, the fossil entomologist has to reconstruct the insect form of a by-gone period, by comparing these few fragments with their allies of the present day, just as Cuvier restored the quadrupeds of the Paris Basin, delineating their often rude, embryonic forms, from hints afforded simply by pieces of bone and disjointed parts of the skeletons, in some